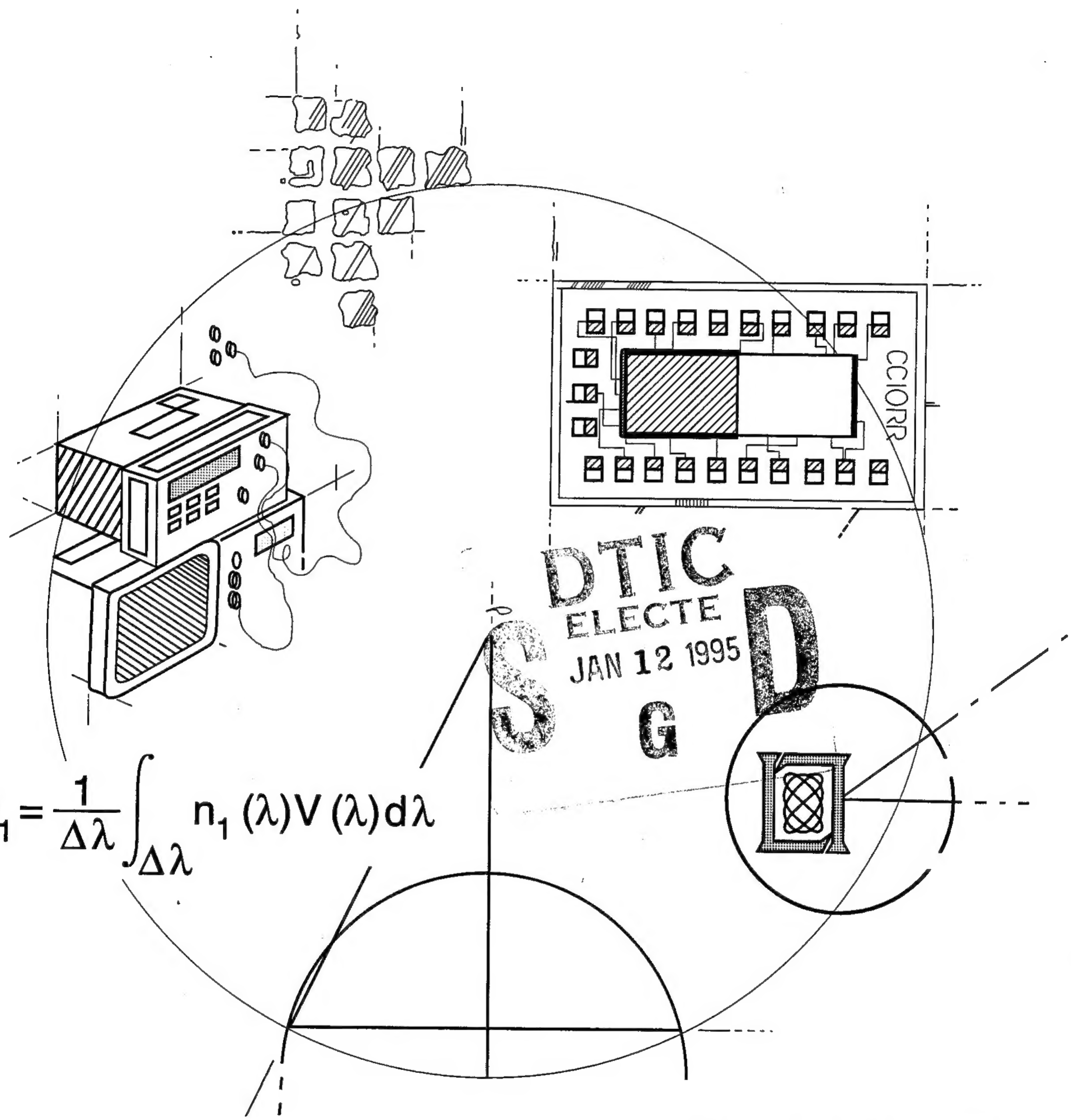
ESC-TR-94-101

Bibliography of Patents and Licenses 1951-1990



Massachusetts Institute of Technology
Lincoln Laboratory

This report is based on studies performed at Lincoln Laboratory, a center for research operated by Massachusetts Institute of Technology. The work was sponsored by the Department of the Air Force under Contract F19628-90-C-0002.

FOR THE COMMANDER

Gary Tutungian
Administrative Contracting Officer
Contracted Support Management

BIBLIOGRAPHY OF PATENTS AND LICENSES
ISSUED TO
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
LINCOLN LABORATORY
1951 – 1990

Prepared by Group 17

Library and Information Services

INTRODUCTION

Since its establishment in 1951, MIT Lincoln Laboratory has actively pursued its mission to "carry out a program of research and development pertinent to national defense with particular emphasis on advanced electronics." Toward this end, the Laboratory promotes scientific and technological research providing the best solutions to address the needs of the nation. By patenting and licensing inventions, technology originally developed to meet the specific needs of the Department of Defense and other government agencies can be applied to solve problems in the civilian sector; this substantially benefits the nation's economy and serves as an impetus for improving society worldwide.

EXECUTIVE SUMMARY

Massachusetts Institute of Technology maintains close ties with industry to enhance both the vitality and relevance of its education and research. This steady flow of ideas between the Institute and the commercial world has established the Institute and Lincoln Laboratory as global leaders in technological competitiveness. For instance, the Laboratory has had a major role in developing diode laser technology for numerous military and civilian applications. Particularly significant has been the development of 1.3-1.5 μm diode lasers, which are now widely used as sources in fiber communications. The Laboratory has contributed significant advances in the areas of radar, physics, electronics, aerospace technology, new materials, communications, optics, lasers, solid state physics, artificial intelligence, neural networks, photovoltaics, superconductivity, semiconductors, health care, and computer hardware and software development; noteworthy contributions have also been made in the fields of air traffic control, environmental science, and solar energy.

Lincoln Laboratory's professional staff of approximately 1,200 members exemplifies the creativity, imagination, and innovation that has generated about seven invention disclosures each month. Eighty-five percent of the professional staff hold advanced degrees, two-thirds of which are in electrical engineering and physics disciplines, with others in diversified scientific fields and subject areas. Their breadth of education, skills, and experience meet the demands of sponsors' changing needs and the challenge to further an integrated approach in solving complex problems.

Since 1951, Lincoln Laboratory has effectively transferred its technology to industry, patenting 243 inventions, 69 of which are licensed, together generating over $21 million. Many of these inventions have been protected worldwide. Moreover, some inventions, like the Solid State Laser of Dr. Aram Mooradian and the Diffractive/Refractive Lens Implant of Dr. Gary J. Swanson (see Selected Profiles in Creativity), can be considered breakthroughs that will bring about the creation of new industries, ensuring Lincoln Laboratory leadership in the scientific and technical communities.

In addition, a large number of "spin-off" companies have been started with Lincoln-developed technology. An example is Digital Equipment Corporation (DEC), founded in 1957 by Kenneth H. Olsen using technology developed at the Laboratory; DEC recently reported an annual sales figure of $12.741 billion and a work force of 124,500 employees worldwide. Another example is Lasertron, begun in 1980, which has a reported $22 million in sales with 230 employees. These are examples of companies that have made effective use of the potential of the Laboratory's research. In fact, Lincoln has an impressive number of spin-off companies: over the years, 63 have been spawned, employing more than 135,000 people and generating more than $14.1 billion in sales annually.[1]

Besides patents, Lincoln Laboratory promotes and furthers the intellectual and economic robustness of the country in several significant ways. Over the years, Laboratory reseachers have authored over 60 books and each year they produce more than 500 journal articles, technical presentations at national and international conferences, and technical reports on a variety of topics in many fields.[2] In 1988, the *LINCOLN LABORATORY JOURNAL* was launched; this publication is distributed to almost 6,000 persons, agencies, institutions, and companies throughout the country.

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1 *Spin-Off Companies from MIT Lincoln Laboratory*, Lexington, Mass.: MIT Lincoln Laboratory (June 1990).

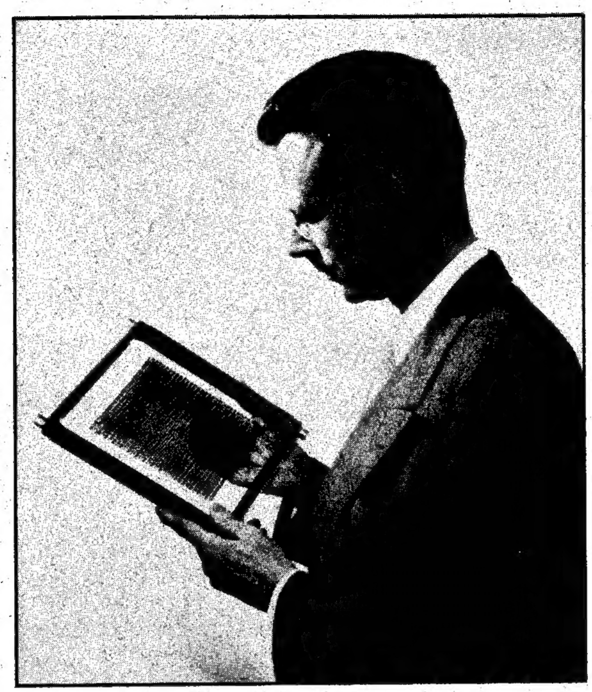
2 *Unclassified Publications of Lincoln Laboratory*, Lexington, Mass.: MIT Lincoln Laboratory (annual).

Finally, the Laboratory exchanges technical information with all branches of the Department of Defense, other government agencies, academia, and industry. This interchange is encouraged by the numerous professional visits made to the Laboratory: each year, over 20,000 visitors are drawn to our technical seminars, workshops, briefings, and demonstrations.

The Technology Licensing Office (TLO)

The Technology Licensing Office works with industry, venture capital sources, and entrepreneurs to find the best way to commercialize the new technologies developed at MIT and Lincoln Laboratory. Historically, the Massachusetts Institute of Technology's approach has been to patent inventions. Four years ago, however, the Institute brought a greater emphasis to licensing. The success of this change is impressive with over 100 patents issued last year alone; 48% of these patents licensed or optioned at the time of issue. A branch office opened at Lincoln Laboratory just two years ago was a direct outcome of this success.

Selected Profiles in Creativity



JAY W. FORRESTER HOLDS AN ARRAY CONTAINING OVER 1000 TINY MAGNETIC CORES DEVELOPED AT MIT TO SERVE AS THE "MEMORY" FOR THE INSTITUTE'S WHIRLWIND I COMPUTER.

JAY FORRESTER received a B.S. in Electrical Engineering from the University of Nebraska and an S.M. in Electrical Engineering from the Massachusetts Institute of Technology. From 1952 until 1956, he was Head of Lincoln Laboratory's Digital Computer Division. In 1956, he joined the MIT faculty as professor at its Sloan School of Management. Since 1972, he has been the Germeshausen Professor of Management at Sloan where he directs the Systems Dynamics Program.

Invention: Multicoordinate Digital Information Storage (Magnetic Core Memory) Device

The magnetic core memory device, patented in 1956, consisted of a plane array of small doughnut-shaped ferrite cores; four wires threaded through each core carry current pulses that were used to sense the information stored in the memory and to write in new information. This concept increased both the speed and reliability of computer memory systems. For over two decades, random-access, coincident-current magnetic storage was the standard memory device for high-speed digital computers. Jay Forrester holds the basic patent for this invention.

United States patent 2,736,880 has been granted for this invention.

DR. ALICE M. CHIANG WITH HER CHARGE-DOMAIN PARALLEL PROCESSING NETWORK.

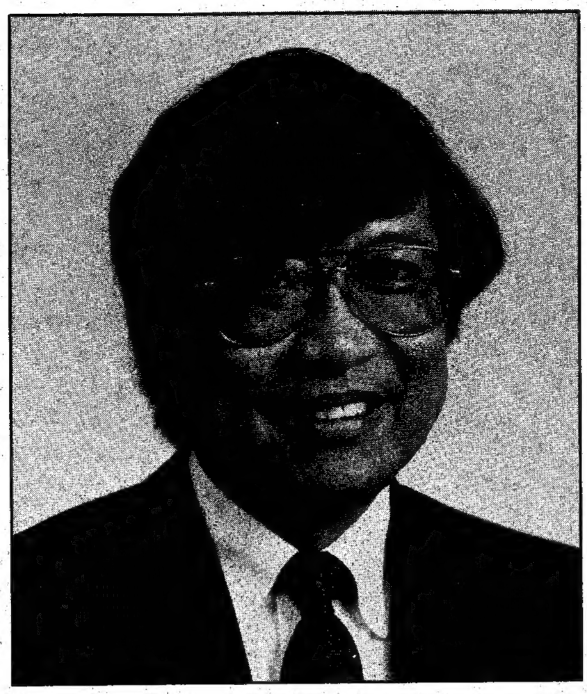
ALICE CHIANG received a B.S. in Physics from the National Taiwan University and a Ph.D. in Physics from Virginia Polytechnic Institute. She is currently a Senior Staff Member in the Microelectronics Group of the Laboratory's Solid State Division.

INVENTION: A CHARGE-DOMAIN PARALLEL PROCESSING NETWORK

A parallel processing architecture was developed based on charge-domain local memories and computing elements. A floating-gate charge-coupled device (CCD) tapped delay line is used for holding and shifting analog charge packets of sampled data. Using an array (or a matrix) of CCD digital-analog multipliers, the output is a charge packet proportional to the sum of the products of the analog sampled data and a set of digital words.

This invention is ideally suited for high-speed, real-time access and computation of a large amount of data in a low-cost, low-power image processing system. Possible applications include aircraft- or spacecraft-mounted weather radar or collision avoidance radar, nationwide computer and time sharing networks for teleconferenced image sharing, medical consultation, multispectral satellite images, facsimile transmission of images ranging from fingerprints to text, and image transmissions over existing telephone networks.

United States patent 4,464,726 has been granted for this invention.



DR. JOHN C.C. FAN'S TRANSPARENT HEAT MIRROR INVENTION PROVIDES HIGH SOLAR TRANSMISSION WITH MINIMAL THERMAL RADIATION LOSS.

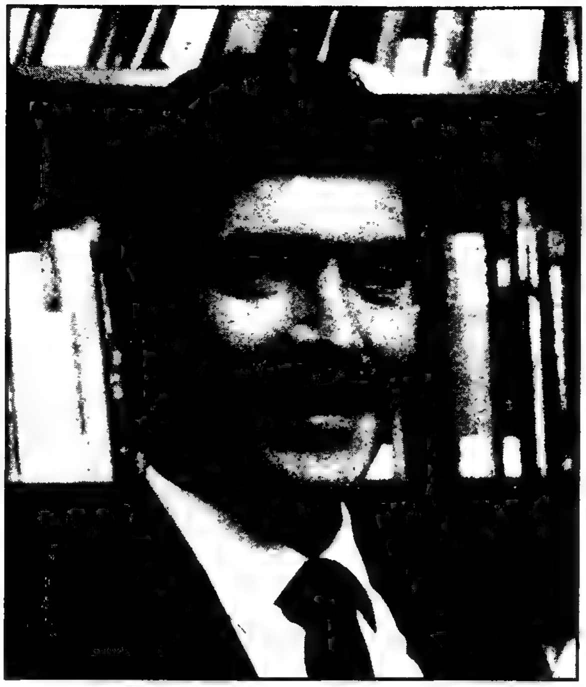
JOHN FAN received a B.S. in Electrical Engineering from the University of California, Berkeley and an M.S. and a Ph.D. in Applied Physics from Harvard University. He is currently the Chairman and Chief Executive Officer of Kopin Corporation in Taunton, Massachusetts. Before founding Kopin in 1984, he was the Associate Group Leader of the Electronic Materials Group in the Laboratory's Solid State Division.

INVENTION: TRANSPARENT HEAT MIRROR

Working with a colleague, John has been granted several patents for the concept of a transparent, composite film, heat mirror. These include a discrete and continuous layer of metallic silver sandwiched between an outer, protective layer that is both transparent and antireflective and a transparent, phase-matching layer. This combination of layers is chosen to provide high solar transmission with minimum loss of thermal radiation.

Transparent heat mirrors allow sunlight and visible light through, but reflect infrared and thermal energy. Some of the applications are coatings for thermal solar collectors, energy saving lightbulbs, thermal windows, and transparent furnaces.

United States patents 4,721,349; 4,556,277; and 4,337,990 have been granted for this concept. These patents have been licensed by MIT to industrial companies, and energy-saving commercial products are available.



DR. MATTHEW W. GANZ DEVELOPED A TECHNIQUE MAKING RADAR SYSTEMS ROBUST IN CONGESTED SIGNAL ENVIRONMENTS.

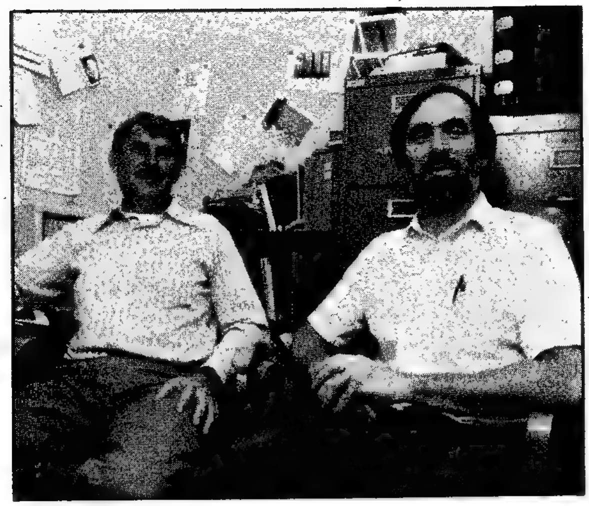
MATTHEW GANZ received a B.S., an M.S., and a Ph.D. in Electrical Engineering from Ohio State University, Columbus. He is currently an Assistant Group Leader in the Radar Systems Group of the Laboratory's Radar Measurements Division.

INVENTION: ADAPTIVE SIDELOBE BLANKER

Modern radar environments are often so congested with multiple signals that both interference and undesired reflections are experienced. Interference or large target returns in the antenna sidelobe region can either mask main-beam targets or cause false detections. In some applications, such interference may be intentionally generated to distract and impede the effectiveness of a radar system.

A technique was developed that allows two interference rejection techniques — adaptive nulling and sidelobe blanking — to be used simultaneously. Each technique prevents a different type of interference and their simultaneous use makes radar systems more robust in congested signal environments. Multiple adaptive antenna patterns are formed for a phased array radar. The signals from the antenna elements are sampled and a covariance matrix formed. The sample matrix inversion technique is implemented using different steering vectors to calculate adapted weights for both the main beam (or beams) and the sidelobe blanker.

United States patent 4,959,653 has been granted for this invention.



MR. NIKOLAY N. EFREMOW, DR. MICHAEL W. GEIS, AND **PROFESSOR HENRY I. SMITH'S** (NOT SHOWN), DIAMOND FILM MOSAICS PRODUCE NEAR SINGLE CRYSTAL QUALITY.

MICHAEL GEIS received a B.A. in Physics, an M.S. in Electrical Engineering, and a Ph.D. in Space Physics and Astronomy, all from Rice University. He is currently a Staff Member in the Submicrometer Technology Group of the Laboratory's Solid State Division.

HENRY SMITH received a B.S. in Physics from Holy Cross, and an M.S. and a Ph.D. in Physics from Boston College. While at the Laboratory, Henry was Assistant Leader in the Microelectronics Group. He is currently the Joseph F. and Nancy P. Keithly Professor of Electrical Engineering at the Massachusetts Institute of Technology.

NIKOLAY EFREMOW received an Associate's Degree in Electrical Engineering from Franklin Institute. He is an Assistant Staff Member in the Submicrometer Technology Group of the Laboratory's Solid State Division.

INVENTION: GROWTH OF LARGE AREA MOSAIC DIAMOND FILMS, APPROACHING SINGLE CRYSTAL QUALITY

Diamond's superior properties of heat conductivity, hardness, high breakdown voltage, and transparency to infrared rays make it a material of great potential value for many important commercial and military applications. However, the inability to obtain large area, single crystal diamond films has limited its practical applicability.

A new technique has been developed that produces large area mosaic films approaching single crystal quality. A silicon substrate is patterned and etched to form saw-tooth gratings or tetrahedral etched pits that conform to the shape of commercially available faceted diamond seeds. When single crystal seeds are deposited on this substrate, they become oriented with respect to the etched structures. When these seeds are used as the starting material for epitaxial growth, large areas of continuous mosaic diamond films are produced, which approach the crystallographic properties of single crystal diamond. At this time there is no other way to obtain such a large area diamond film with this degree of crystal quality approaching a single crystal diamond.

A patent application for this invention has been filed.

DR. LEONARD M. JOHNSON DEMONSTRATES AN APPARATUS FOR IMPROVING THE LINEARITY OF INTEGRATED-OPTICAL MODULATORS HAVING MILITARY AND COMMERCIAL USE.

LEONARD JOHNSON

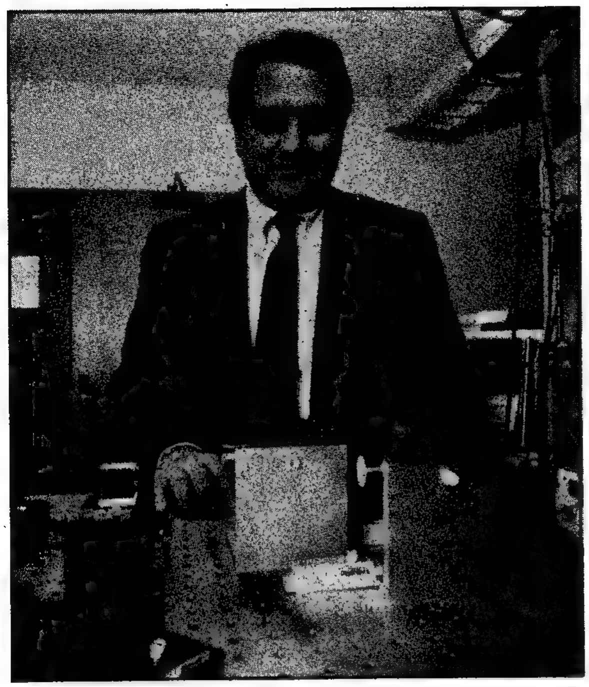
a native of Massachusetts, received his S.B., S.M., and Ph.D. degrees, all in Electrical Engineering, from the Massachusetts Institute of Technology. He is currently a Staff Member in the Electrooptical Devices Group of the Laboratory's Solid State Division.

INVENTION: APPARATUS AND METHOD FOR REDUCING MODULATOR NONLINEARITIES

An apparatus and method have been conceived and demonstrated for reducing optical modulator nonlinearities. High-linearity optical modulators are required for accurately transmitting analog signals with low distortion on low-loss optical fibers. The basic technique that has been developed for improving the linearity (optical transmission versus applied voltage) of integrated-optical modulators involves a cancellation scheme based on operating the modulator in two optical polarization states simultaneously. Using this technique, linear optical modulation at frequencies up to tens of gigahertz can be obtained.

Analog fiber-optic links employing linearized integrated-optical modulators are becoming increasingly attractive for both military and commercial applications, including phased-array radar signal distribution and cable television fiber-optic networks.

A patent application for this invention has been filed.



DR. ARAM MOORADIAN INVENTED A SOLID STATE LASER THAT HAS OPTICAL COMMUNICATIONS, LASER PRINTING, AND MEDICAL LASER APPLICATIONS, AMONG OTHERS.

ARAM MOORADIAN received a B.S. in Physics from the Worcester Polytechnic Institute and a Ph.D., also in Physics, from Purdue University. He is currently the Group Leader of the Quantum Electronics Group in the Laboratory's Solid State Division.

INVENTION: SOLID STATE LASER

Aram has invented a solid state, optically pumped microlaser. Although the laser is very small, it operates with precision frequency control, narrow linewidth, and tunability. It can be mass produced at very low cost using semiconductor processing and packaging technology.

Applications include optical communications, laser printing, projection display (including consumer television), robotics control, medical laser uses, and materials processing.

United States patent 4,860,304 has been granted for this invention.

A. GREGORY ROCCO, JR. DESIGNED A DEVICE CAPABLE OF PREVENTING MAJOR COMPUTER NETWORK DISRUPTIONS.

A. GREGORY ROCCO

received a B.S. in Electrical Engineering from the University of New Hampshire and an M.S., also in Electrical Engineering, from Purdue University. He is currently a Staff Member in the Battlefield Surveillance Group of the Laboratory's Surveillance and Control Division.

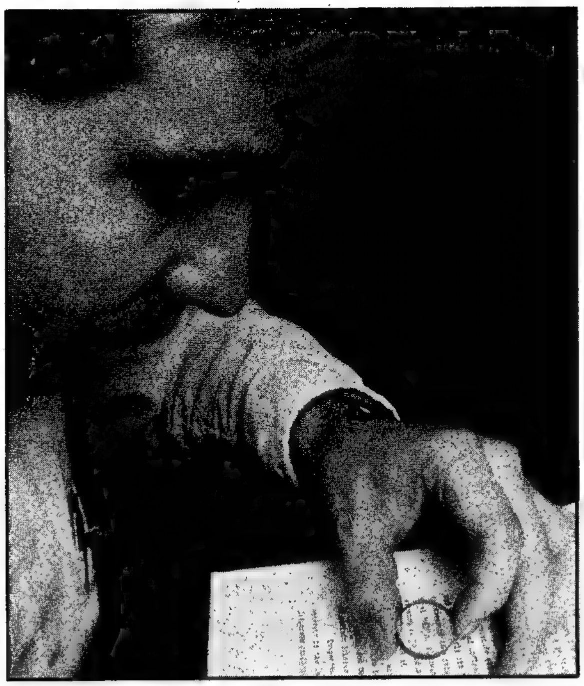
INVENTION: AUTOSPLIT

A token passing ring is a method of interconnecting computer systems. The machines or nodes are connected in series, with the output of one machine feeding the input to the next, creating a network in the form of a unidirectional communications ring. Any node in this ring may originate a message that is then passed from one node to the next until it arrives at its destination node. Normally, if the ring is broken, it goes down and the machines on the ring can no longer communicate with each other.

In installations of more than a few nodes, the ring is divided into subrings. These subrings are connected together at one or more central locations. At these locations there are switches that allow each subring to be switched in and out of the network. When any subring goes down, the entire network can be affected until the faulty subring is identified by an operator and switched off the main network. This restores network communications to all machines in the network except those on the malfunctioning subring. It takes time to recognize that the network is down, locate the malfunctioning subring, and flip the appropriate switch. Since it is not uncommon for system jobs to be run overnight or, in some cases, for several days, a system abort can be quite a serious disruption for many users.

Greg has invented a device he calls "Autosplit," which is designed to automatically recognize a network failure and switch out the faulty subring. This will generally be done fast enough to prevent a major disruption in ongoing work, except, of course, for the nodes on the malfunctioning subring.

A patent application has been filed.



DR. GARY J. SWANSON LOOKS THROUGH A DIFFRACTIVE/REFRACTIVE LENS THAT WILL IMPROVE VISUAL IMAGE AND COLOR IN BIFOCAL LENS IMPLANTS.

GARY SWANSON received a B.S. in Mathematics and a Ph.D. in Physics from the University of Michigan. He is currently a Staff Member in the Laser Radar Measurements Group of the Laboratory's Optics Division.

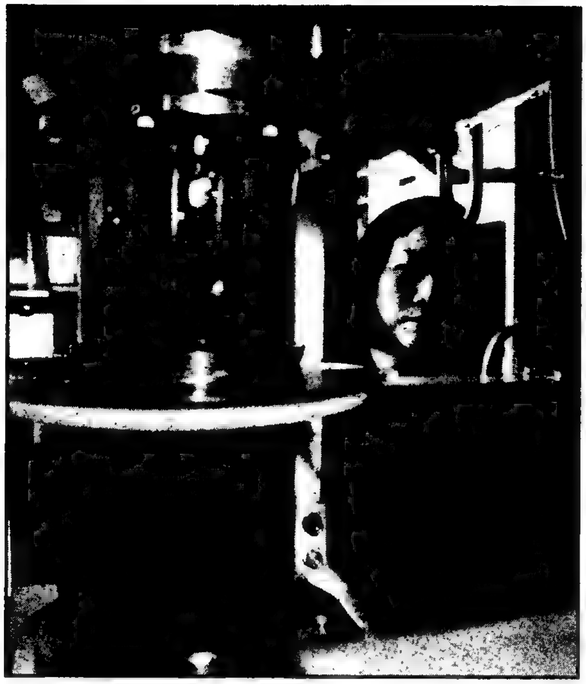
INVENTION: DIFFRACTIVE/REFRACTIVE LENS IMPLANT

Cataract patients commonly have their damaged natural lenses removed and replaced with artificial lens implants. The lenses usually implanted are refractive, i.e., they refract, or bend, light passing through them. The refractive lenses that are usually implanted only correct the focus on distant objects so patients need eyeglasses to see objects closer to them.

Diffraction is the breaking up or scattering of light as it passes by objects in its path. This effect can be achieved on a lens by covering its surface with a series of stepped ridges or notches. By constructing a "binary" lens that has both refractive and diffractive areas, bifocal vision is possible in one implanted lens.

This invention uses a nonrotationally symmetric diffractive structure placed on a refractive lens implant. The advantage of this design over other diffractive/refractive designs is an increase in image clarity and a reduction in false image coloration.

A patent application for this invention has been submitted.



DR. CHRISTINE A. WANG (IN PHOTO), **PROFESSOR ROBERT A.BROWN**, AND **MR. JAMES W. CAUNT** BUILT A REACTOR THAT PRODUCES SEMICONDUCTOR FILMS USED IN SPACE COMMUNICATIONS, OPTICAL RECORDING, AND OPTICAL COMPUTING.

CHRISTINE WANG received an S.B. in Materials Science and Engineering, an S.M. in Metallurgy, and a Ph.D. in Electronic Materials, all from the Massachusetts Institute of Technology. She is currently a Staff Member in the Electronic Materials Group of the Laboratory's Solid State Division.

JAMES CAUNT received an Associate's Degree in Mechanical Engineering from the Wentworth Institute of Technology, a B.S. in Industrial Technology from Northeastern University, and an MBA from Babson College. He is currently an Assistant Staff Member in the Laboratory's Solid State Division.

ROBERT BROWN received a B.S. and an M.S. from the University of Texas at Austin and a Ph.D. from the University of Minnesota. He is currently the Arthur D. Little Professor and Head of the Department of Chemical Engineering at the Massachusetts Institute of Technology.

INVENTION: VAPOR PHASE REACTOR FOR MAKING MULTILAYER STRUCTURES

A new reactor for producing semiconductor epitaxial layers such as GaAs, AlGaAs, and InGaAs has been designed, built, and tested. Results show that the reactor produces the most precisely controlled and uniform semiconductor films reported to date. Recognizing that the specific dynamics of the gas in the reactor have a profound influence on film quality, the researchers used a light-scattering technique to visualize the gas flow in the reactor. A numerical model of

reactor fluid flow and heat and mass transfer was developed to simulate epitaxial growth and to establish critical parameters for fabricating uniform layers with abrupt compositional changes.

The reactor, which permits the highly reproducible production of these epilayers, will increase yields and reduce production costs. The uniformity is especially critical for diode-pumped solid state lasers used in military applications, micro- and macro-machining, and medical applications, as well as for coherent diode laser arrays used in space communications, optical recording, and optical computing. In addition, reduced maintenance and simplicity of design are attractive for commercialization.

This invention has received a Notice of Allowability. The Air Force is soliciting proposals for an SBIR (Small Business Innovative Research) grant to develop this concept into a commercial product.

List of Patents

U.S. Patent No.			
2,736,880*	Multicoordinate Digital Information Storage Device	Forrester, J.W.	28 Feb 56
2,975,342	Narrow Base Planar Junction Punch-Thru Diode	Rediker, R.H.	14 Mar 61
2,978,704	Radome Structural Devices	Cohen, A. Davis, P. Orabona, J.F.	4 Apr 61
2,982,852	Anti-Multipath Communication System	Fano, R.M.	2 May 61
2,982,853	Anti-Multipath Receiving System	Price, R. Green, P.E., Jr.	2 May 61
2,990,259	Syringe-Type Single-Crystal Furnace	Moody, P.L. Kolm, C.R.	27 Jun 61
2,994,808	High Flux Density Apparatus	Kolm, H.H.	1 Aug 61
3,010,031	Symmetrical Back-Clamped Transistor Switching Circuit	Baker, R.H.	21 Nov 61
3,011,711	Cryogenic Computing Devices	Buck, D.A.	5 Dec 61
3,037,195	Data Filtering System	Bivans, E.W.	29 May 62
3,077,578	Semiconductor Switching Matrix	Kingston, R.H. McWhorter, A.L.	12 Feb 63
3,167,663	Magneto-Semiconductor Devices	Melngailis, I. Calawa, A.R. Rediker, R.H.	26 Jan 65
3,200,299	Superconducting Electromagnet	Autler, S.H.	10 Aug 65
3,281,802	Magnetic Memory Core	McMahon, R.E.	25 Oct 66
3,289,110*	Non-Reciprocal Multi-Element TEM Transmission Line Device	Weiss, J.A.	29 Nov 66
3,304,519	High-Frequency Circulator Having a Plurality of Differential Phase Shifters and Intentional Mismatch Means	Weiss, J.A.	14 Feb 67

* Patent has been licensed

U.S. Patent No.			
3,324,334*	Induction Plasma Torch with Means for Recirculating the Plasma	Reed, T.B.	6 Jun 67
3,382,161	Electrolytic Separation of Transition Metal Oxide Crystals	Kunnmann, W. Ferretti, A. Arnott, R.J. Rogers, D.B.	7 May 68
3,393,957	High-Frequency Light Modulator or Switch Using the Magneto-Optical Properties of Thin Magnetic Films	Smith, D.O.	23 Jul 68
3,395,345	Method and Means for Detecting the Period of a Complex Electrical Signal	Rader, C.M.	30 Jul 68
3,425,051	Analog-to-Digital Converter	Smith, W.W.	28 Jan 69
3,448,421	Shielded Magnetic Core	Berg, R.S. Howland, B.	3 Jun 69
3,488,644	Non-Destructive Read-Out Circuit for a Magnetic Memory Core	McMahon, R.E.	6 Jan 70
3,493,943	Magnetoresistive Associative Memory	Raffel, J.I.	3 Feb 70
3,495,224	Thin Film Memory System	Raffel, J.I.	10 Feb 70
3,497,698	Metal Insulator Semiconductor Radiation Detector	Phelan, R.J., Jr. Dimmock, J.O.	24 Feb 70
3,500,354	Content-Addressed Memory Using Optical Interrogation	Smith, D.O. Harte, K.J.	10 Mar 70
3,515,606	Methods of Improving Magnetic Characteristics of Films for Memory Application	Crowther, T.S.	2 Jun 70
3,516,080	Magneto-Optical Memory Sensing Using Thermal Modulation	Smith, D.O.	2 Jun 70
3,518,578	Signal Compression and Expansion System	Oppenheim, A.V. Stockham, T.G., Jr.	30 Jun 70
3,521,835	Synchronous Satellite	Braga-Illa, A.A. Morrow, W.E., Jr.	28 Jul 70

* Patent has been licensed

U.S. Patent No.			
3,566,383	Methods of Improving the Signal-to-Noise Ratio of Photon and Electron Beam Accessed Magnetic Film Memory System	Smith, D.O.	23 Feb 71
3,568,087	Optically Pumped Semiconductor Laser	Phelan, R.J., Jr. Rediker, R.H.	2 Mar 71
3,590,248	Laser Arrays	Chatterton, E.J., Jr	29 Jun 71
3,619,067*	Method and Apparatus for Determining Optical Focal Distance	Howland, B. Proll, A.F.	9 Nov 71
3,625,660*	Method and Structure for Growing Crystals	Reed, T.B. Pollard, E.R.	7 Dec 71
3,626,154*	Transport Furnace	Reed, T.B.	7 Dec 71
3,636,471	Method of and Apparatus for Enhancing Radiation from Indirect-Gap Semiconductors	Rediker, R.H.	18 Jan 72
3,649,838	Semiconductor Device for Producing Radiation in Response to Incident Radiation	Phelan, R.J., Jr.	14 Mar 72
3,655,986	Laser Device	Lax, B.	11 Apr 72
3,676,795	Multiple-Frequency Laser Apparatus and Method	Pratt, G.W., Jr.	11 Jul 72
3,703,958	Eddy Current Apparatus and Method of Application to a Conductive Material	Kolm, H.H.	28 Nov 72
3,720,884*	Method and Apparatus for Compression of Optical Laser Pulses	Kelley, P.L. Fisher, R.A. Gustafson, T.K.	13 Mar 73
3,742,229*	Soft X-Ray Mask Alignment System	Smith, H.I. Spears, D.L. Stern, E.	26 Jun 73
3,742,230*	Soft X-Ray Mask Support Substrate	Spears, D.L. Smith, H.I. Stern, E.	26 Jun 73

* Patent has been licensed

U.S. Patent No.			
3,743,842*	Soft X-Ray Lithographic Apparatus and Process	Smith, H.I. Spears, D.L. Stern, E.	3 Jul 73
3,746,867	Radiation Responsive Signal Storage Device	Phelan, R.J., Jr. Dimmock, J.O.	17 Jul 73
3,748,593	Method and Means of Construction of a Semiconductor Material for Use as a Laser	Dimmock, J.O. Melngailis, I. Strauss, A.J.	24 Jul 73
3,768,417	Transportation System Employing an Electromagnetically Suspended, Guided and Propelled Vehicle	Thornton, R.D. Kolm, H.H.	30 Oct 73
3,789,327	Micro-Acoustic Waveguide	Waldron, R.A. Stern, E.	29 Jan 74
3,794,844	Method and Means of Construction of a Semiconductor Material for Use in a Laser	Dimmock, J.O. Melngailis, I. Strauss, A.J.	26 Feb 74
3,818,243	Error Correction by Redundant Pulse Powered Circuits	McMahon, R.E.	18 Jun 74
3,831,173*	Ground Radar System	Lerner, R.M.	20 Aug 74
3,842,751	Transportation System Employing an Electromagnetically Suspended, Guided and Propelled Vehicle	Thornton, R.D. Kolm, H.H.	22 Oct 74
3,857,990	Heat Pipe Furnace	Steininger, J. Reed, T.B.	31 Dec 74
3,863,070	Quantum Mechanical MOSFET Infrared Radiation Detector	Wheeler, R.H. Ralston, R.W.	28 Jan 75
3,869,618	High-Power Tunable Far-Infrared and Submillimeter Source	Lax, B. Aggarwal, R.L.	4 Mar 75
3,871,017	High-Frequency Phonon Generating Apparatus and Method	Pratt, G.W., Jr.	11 Mar 75
3,871,215	Opto-Electronic Apparatus to Generate a Pulse-Modulated Signal Indicative of the Mechanical State of a System	Pratt, G.W., Jr. McMullin, P.G.	18 Mar 75

* Patent has been licensed

U.S. Patent No.			
3,871,301	Stabilization and Ride Control of Suspended Vehicles Propelled by a Linear Motor	Kolm, H.H. Thornton, R.D.	18 Mar 75
3,879,235	Method of Growing from Solution Materials Exhibiting a Peltier Effect at the Solid-Melt Interface	Gatos, H.C. Witt, A.F. Lichtensteiger, M.	22 Apr 75
3,883,831	Surface Wave Devices	Williamson, R.C. Stern, E.	13 May 75
3,886,530*	Signal Storage Device	Huber, E.E., Jr. Cohen, M.S., Jr. Smith, D.O.	27 May 75
3,887,937	Semiconductor Sensor	Gatos, H.C. Lagowski, J.	3 Jun 75
3,897,766	Apparatus Adapted to Opto-Electrically Monitor the Output of a Prime Mover to Provide Signals Which Are Fed Back to the Input and Thereby Provide Control of the Prime Mover	Pratt, G.W., Jr. McMullin, P.G.	5 Sep 75
3,912,394	Method and System of Interferometric Measurements of Modulation Transfer Functions	Kelsall, D.	14 Oct 75
3,927,385	Light Emitting Diode	Pratt, G.W., Jr.	16 Dec 75
3,941,670	Method of Altering Biological and Chemical Activity of Molecular Species	Pratt, G.W., Jr.	2 Mar 76
3,950,645	Infrared Detection Tube	Rotstein, J. Keyes, R.J.	13 Apr 76
3,963,515	Vacuum Cleaning	Haldeman, C.W. Covert, E.E.	15 Jun 76
3,965,277	Photoformed Plated Interconnection of Embedded Integrated Circuit Chips	Guditz, E.A. Burke, R.L.	22 Jun 76
3,974,382*	Lithographic Mask Attraction System	Bernacki, S.E.	10 Aug 76

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U.S. Patent No.			
3,974,412	Spark Plug Employing Both Corona Discharge and Arc Discharge and a System Employing the Same	Pratt, G.W., Jr.	10 Aug 76
3,984,680	Soft X-Ray Mask Alignment System	Smith, H.I.	5 Oct 76
4,011,745	Semiconductor Sensors	Gatos, H.C. Lagowski, J.	15 Mar 77
4,016,412	Surface Wave Devices for Processing Signals	Stern, E. Williamson, R.C.	5 Apr 77
4,020,388	Discharge Device	Pratt, G.W., Jr.	26 Apr 77
4,027,383	Integrated Circuit Packaging	Herndon, T.O. Raffel, J.I.	7 Jun 77
4,038,216	Material and Method of Making Secondary-Electron Emitters	Henrich, V.E. Fan, J.C.C.	26 Jul 77
4,049,891	Compositions for Fast Alkali-Metal-Ion Transport	Hong, H.Y-P. Goodenough, J.B.	20 Sep 77
4,055,758	Surface Wave Devices for Processing Signals	Stern, E. Williamson, R.C. Bers, A. Cafarella, J.H.	25 Oct 77
4,059,461*	Method for Improving the Crystallinity of Semiconductor Films by Laser Beam Scanning and the Products Thereof	Fan, J.C.C. Zeiger, H.J.	22 Nov 77
4,063,105	Method of and Apparatus for Generating Tunable Coherent Radiation by Noncollinear Phase-Matched Sum-Difference Frequency Optical Mixing	Aggarwal, R.L. Lee, N.K. Lax, B.	13 Dec 77
4,066,984	Surface Acoustic Wave Devices for Processing and Storing Signals	Stern, E. Ingebrigtsen, K.A.	3 Jan 78
4,067,037	Transistor Having High FT at Low Currents	Greiff, P.	3 Jan 78
4,075,706	Surface Wave Devices for Processing Signals	Stern, E. Williamson, R.C. Smith, H.I.	21 Feb 78

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4,087,719	Spark Plug	Pratt, G.W., Jr.	2 May 78
4,087,976	Electric Power Plant Using Electrolytic Cell-Fuel Cell Combination	Morrow, W.E., Jr. Hsu, M.S.	9 May 78
4,093,927*	Pulsed Gas Laser	Levine, J.S.	6 Jun 78
4,101,965	Surface Acoustic Wave Devices for Processing and Storing Signals	Ingebrigtsen, K.A. Bers, A. Cafarella, J.H.	18 Jul 78
4,107,544	Two-Photon Resonant Laser Mixing in Molecular Liquids	Kildal, H. Brueck, S.R.J.	15 Aug 78
4,115,228	Method of Making Secondary Electron Emitters	Henrich, V.E. Fan, J.C.C.	19 Sep 78
4,115,280	Apparatus for Altering the Biological and Chemical Activity of Molecular Species	Pratt, G.W., Jr.	19 Sep 78
4,117,103	Lithium Ion Transport Compositions	Hong, H.Y-P.	26 Sep 78
4,119,855	Nonvacuum Soft X-Ray Lithographic Source	Bernacki, S.E.	10 Oct 78
4,127,900	Reading Capacitor Memories with a Variable Voltage Ramp	Raffel, J.I. Yasaitis, J.A.	28 Nov 78
4,140,369	Efficient Light Diffuser	Howland, B.	20 Feb 79
4,142,924*	Fast-Sweep Growth Method for Growing Layers Using Liquid Phase Epitaxy	Hsieh, J.J.	6 Mar 79
4,150,177	Method for Selectively Nickeling a Layer of Polymerized Polyester Resin	Guditz, E.A. Burke, R.L.	17 Apr 79
4,166,669	Planar Optical Waveguide, Modulator, Variable Coupler and Switch	Leonberger, F.J. Donnelly, J.P.	4 Sep 79
4,170,512	Method of Manufacture of a Soft-X-Ray Mask	Flanders, D.C. Smith, H.I. Dalomba, M.A.	9 Oct 79
4,172,882	Lithium Ion Transport Compositions	Hong, H.Y-P.	30 Oct 79

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4,186,045	Method of Epitaxial Growth Employing Electromigration	Gatos, H.C. Jastrzebski, L.L.	29 Jan 80
4,197,141*	Method for Passivating Imperfections in Semiconductor Materials	Bozler, C.O. Fan, J.C.C.	8 Apr 80
4,200,395	Alignment of Diffraction Gratings	Smith, H.I. Austin, S.S. Flanders, D.C.	29 Apr 80
4,220,510	Method for Separating Isotopes in the Liquid Phase at Cryogenic Temperature	Brueck, S.R.J. Osgood, R.M., Jr.	2 Sep 80
4,227,941*	Shallow-Homojunction Solar Cells	Bozler, C.O. Chapman, R.L. Fan, J.C.C. McClelland, R.W.	14 Oct 80
4,231,819	Dielectric Isolation Method Using Shallow Oxide and Polycrystalline Silicon Utilizing a Preliminary Etching Step	Raffel, J.I. Bernacki, S.E.	4 Nov 80
4,242,736	Capacitor Memory and Methods for Reading, Writing, and Fabricating Capacitor Memories	Raffel, J.I. Yasaitis, J.A.	30 Dec 80
4,248,675*	Method of Forming Electrical Contact and Antireflection Layer on Solar Cells	Bozler, C.O. Chapman, R.L. Fan, J.C.C. McClelland, R.W.	3 Feb 81
4,248,687*	Method of Forming Transparent Heat Mirrors on Polymeric Substrates	Fan, J.C.C.	3 Feb 81
4,254,174	Supported Membrane Composite Structure and Its Method of Manufacture	Flanders, D.C. Smith, H.I. Dalomba, M.A.	3 Mar 81
4,256,787	Orientation of Ordered Liquids and Their Use in Devices	Shaver, D.C. Smith, H.I. Flanders, D.C.	17 Mar 81

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4,258,375*	GaInAsP/InP Avalanche Photodiode and Method for Its Fabrication	Hsieh, J.J. Hurwitz, C.E.	24 Mar 81
4,268,095	Magnetic Bearing	Millner, A.R.	19 May 81
4,268,808	Acoustic Wave Device	Melngailis, J.	19 May 81
4,274,737	Test Patterns for Lens Evaluation	Howland, B.	23 Jun 81
4,283,235	Dielectric Isolation Using Shallow Oxide and Polycrystalline Silicon Utilizing Selective Oxidation	Raffel, J.I. Bernacki, S.E.	11 Aug 81
4,287,235	X-Ray Lithography at (About) 100 Angstroms Linewidths Using X-Ray Masks Fabricated by Shadowing Techniques	Flanders, D.C.	1 Sep 81
4,287,485*	GaInAsP/InP Double-Heterostructure Lasers	Hsieh, J.J.	1 Sep 81
4,290,118	Solid State Devices Combining the Use of Surface-Acoustic-Wave Devices and Charge-Coupled Devices	Stern, E. Ralston, R.W. Smythe, D.L., Jr. Burke, B.E.	15 Sep 81
4,291,390	Analog Solid State Memory	Stern, E. Ralston, R.W. Smythe, D.L., Jr. Burke, B.E.	22 Sep 81
4,298,280	Infrared Radar System	Harney, R.C.	3 Nov 81
4,298,953	Programmable Zero-Bias Floating Gate Tapping Method and Apparatus	Munroe, S.C.	3 Nov 81
4,309,225*	Method of Crystallizing Amorphous Material with a Moving Energy Beam	Fan, J.C.C. Zeiger, H.J.	5 Jan 82
4,312,915	Cermet Film Selective Black Absorber	Fan, J.C.C.	26 Jan 82
4,313,159	Data Storage and Access Appartus	Shoap, S.D.	26 Jan 82
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4,323,422	Method for Preparing Optically Flat Damage-Free Surface	Calawa, A.R. Gormley, J.V. Manfra, M.J.	6 Apr 82
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4,337,990*	Transparent Heat-Mirror	Fan, J.C.C. Bachner, F.J.	6 Jul 82
4,340,305	Plate Aligning	Smith, H.I. Austin, S.S. Flanders, D.C.	20 Jul 82
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4,342,970	Acoustic Wave Device	Melngailis, J. Haus, H.A. Lattes, A.L.	3 Aug 82
4,352,105	Display System	Harney, R.C.	28 Sep 82
4,357,183*	Heteroepitaxy of Germanium Silicon on Silicon Utilizing Alloying Control	Fan, J.C.C. Gale, R.P.	2 Nov 82
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4,376,285	High Speed Optoelectronic Switch	Leonberger, F.J. O'Donnell, F.J.	8 Mar 83
4,378,629*	Semiconductor Embedded Layer Technology Including Permeable Base Transistor, Fabrication Method	Bozler, C.O. Alley, G.D. Lindley, W.T. Murphy, R.A.	5 Apr 83
4,382,660	Optical Transistors and Logic Circuits Embodying the Same	Pratt, G.W., Jr. Jain, K.	10 May 83
4,384,299	Capacitor Memory and Methods for Reading, Writing, and Fabricating Capacitor Memories	Raffel, J.I. Yasaitis, J.A.	17 May 83
4,410,237	Method and Apparatus for Shaping Electromagnetic Beams	Veldkamp, W.B.	18 Oct 83
4,420,873	Optical Guided Wave Devices Employing Semiconductor-Insulator Structures	Leonberger, F.J. Melngailis, I. Bozler, C.O. McClelland, R.W.	20 Dec 83
4,426,712	Correlation System for Global Position Receiver	Gorski-Popiel, G.	17 Jan 84
4,438,520	System for Regenerating a Data Word on a Communications Ring	Saltzer, J.H.	20 Mar 84
4,442,166	Cermet Film Selective-Black Absorber	Fan, J.C.C.	10 Apr 84
4,444,992	Photovoltaic-Thermal Collectors	Cox, C.H., III	24 Apr 84
4,447,149	Pulsed Laser Radar Apparatus	Marcus, S. Quist, T.M.	8 May 84
4,454,371	Solar Energy Concentrator System	Folino, F.A.	12 Jun 84
4,458,324	Charge Domain Multiplying Device	Burke, B.E. Chiang, A.M. Lindley, W.T.	3 Jul 84

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4,473,805	Phase Lock Loss Detector	Guhn, D.K.	25 Sep 84
4,479,224	Fiber-Coupled External Cavity Semiconductor Laser	Rediker, R.H.	23 Oct 84
4,479,846	Method of Entraining Dislocations and Other Crystalline Defects in Heated Film Contacting Patterned Region	Smith, H.I. Geis, M.W.	30 Oct 84
4,489,390	Spatial Filter System	Parenti, R.R. Keicher, W.E.	18 Dec 84
4,490,445	Solid Oxide Electrochemical Energy Converter	Hsu, M.S.	25 Dec 84
4,499,441	Superconducting Signal Processing Circuits	Lynch, J.T. Anderson, A.C. Withers, R.S. Wright, P.V.	12 Feb 85
4,501,966	Infrared Microscope Inspection Apparatus	Forman, S.E. Caunt, J.W.	26 Feb 85
4,508,431	Photorefractive Laser Beam-steering Device	Henshaw, P.D.	2 Apr 85
4,511,216	High Power Laser Dump	Hsu, M.S. Hsu, J.P.	16 Apr 85
4,514,581*	Solar Cells Having Ultrathin Active Layers	Fan, J.C.C. Bozler, C.O.	30 Apr 85
4,518,219	Optical Guided Wave Devices Employing Semiconductor-Insulator Structures	Leonberger, F.J. Melngailis, I. Bozler, C.O. McClelland, R.W.	21 May 85
4,525,871	High Speed Optoelectronic Mixer	Foyt, A.G. Leonberger, F.J. Williamson, R.C.	25 Jun 85

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4,553,265	Monolithic Single and Double Sideband Mixer Apparatus	Clifton, B.J. Alley, G.D.	12 Nov 85
4,556,277*	Transparent Heat-Mirror	Fan, J.C.C. Bachner, F.J.	3 Dec 85
4,558,290	A Compact Broadband Rectangular to Coaxial Waveguide Junction	Lee, J.C.	10 Dec 85
4,563,765	Intra-Cavity Loss-Modulated Diode Laser	Tsang, D.Z. Walpole, J.N.	7 Jan 86
4,565,599*	Graphoepitaxy by Encapsulation	Geis, M.W. Smith, H.I. Antoniadis, D. Flanders, D.C.	21 Jan 86
4,567,110	High-Temperature Brazed Ceramic Joints	Jarvinen, P.O.	28 Jan 86
4,585,490	Method of Making a Conductive Path in Multi-Layer Metal Structures by Low Power Laser Beam	Raffel, J.I. Yasaitis, J.A. Chapman, G.H. Naiman, M.L.	29 Apr 86
4,608,117	Maskless Growth of Patterned Films	Ehrlich, D.J. Deutsch, T.F. Osgood, R.M., Jr. Schlossberg, H.	26 Aug 86
4,609,890	Bulk Acoustic Wave Signal Processing Devices	Oates, D.E. Wright, P.V.	2 Sep 86
4,614,628	Solid Electrolyte Structure and Method for Forming	Hsu, M.S. Wilson, C.F.	30 Sep 86
4,615,904	Method for Maskless Growth of Patterned Films	Ehrlich, D.J. Deutsch, T.F. Osgood, R.M., Jr. Schlossberg, H.	7 Oct 86
4,618,261	Optical Gap Measuring	Flanders, D.C. Lyszczarz, T.M.	21 Oct 86

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4,636,404	Method and Apparatus for Forming Low Resistance Lateral Links in a Semiconductor Device	Raffel, J.I. Yasaitis, J.A. Chapman, G.H.	13 Jan 87
4,642,142	Process for Making Mercury Cadmium Telluride	Harman, T.C.	10 Feb 87
4,644,751	Integrated Fuel-Cell/Steam Plant for Electrical Generation	Hsu, M.S.	24 Feb 87
4,649,351	Apparatus and Method for Coherently Adding Laser Beams	Veldkamp, W.B. Leger, J.R. Swanson, G.J.	10 Mar 87
4,652,926	Solid State Imaging Technique	Withers, R.S. Ralston, R.W. Stern, E.	24 Mar 87
4,662,860	Telescoping Low Vibration Pulling Mechanism for Czochralski Crystal Growth	Iseler, G.W. Ahern, B.S.	5 May 87
4,668,528*	Method and Apparatus for Photodeposition of Films on Surfaces	Ehrlich, D.J. Arnone, C. Rothschild, M.	26 May 87
4,670,088*	Lateral Epitaxial Growth by Seeded Solidification	Tsaur, B-Y. Fan, J.C.C. Geis, M.W.	2 Jun 87
4,672,254	Surface Acoustic Wave Devices and Method of Manufacture Thereof	Dolat, V.S. Ehrlich, D.J. Tsao, J.Y.	9 Jun 87
4,690,551	Laser Radar Utilizing Pulse-Tone Waveform	Edwards, B.E. Biron, D.G.	1 Sep 87

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4,700,461*	Process for Making Junction Field-Effect Transistors	Choi, H-K. Tsaur, B-Y.	20 Oct 87
4,710,959	Voice Encoder and Synthesizer	Feldman, J.A. Hofstetter, E.M.	1 Dec 87
4,718,070*	Surface Emitting Diode Laser	Liau, Z-L. Walpole, J.N.	5 Jan 88
4,721,349*	Transparent Heat-Mirror	Fan, J.C.C. Bachner, F.J.	26 Jan 88
4,722,092*	GaInAsP/InP Distributed Feedback Laser	Liau, Z-L. Flanders, D.C. Walpole, J.N.	26 Jan 88
4,727,047*	Method of Producing Sheets of Crystalline Material	Bozler, C.O. Fan, J.C.C. McClelland, R.W.	23 Feb 88
4,734,152	Dry Etching Patterning of Electrical and Optical Mate-rials	Geis, M.W. Efremow, N., Jr. Pang, S.W.	29 Mar 88
4,742,510	Near and Far Echo Canceller for Data Communications	Quatieri, T.F. O'Leary, G.C.	3 May 88
4,745,452	Tunneling Transfer Devices	Sollner, T.C.L.G.	17 May 88
4,746,620	Lateral P-I-N Photodetector	Diadiuk, V. Groves, S.H.	24 May 88
4,748,045*	Method and Apparatus for Photo-deposition of Films on Surfaces	Ehrlich, D.J. Rothschild, M.	31 May 88
4,756,927*	Method and Apparatus for Refractory Metal Deposition	Black, J.G. Ehrlich, D.J.	12 Jul 88
4,774,205*	Monolithic Integration of Silicon and Gallium Arsenide Devices	Choi, H-K. Tsaur, B-Y. Turner, G.W.	27 Sep 88
4,777,148*	Process for Making a Mesa GaInAsP/InP Distributed Feedback Laser	Liau, Z-L. Flanders, D.C. Walpole, J.N.	11 Oct 88

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4,794,556	Method and Apparatus for Sampling In-Phase and Quadrature Components	Rader, C.M.	27 Dec 88
4,798,437	Method and Apparatus for Processing Analog Optical Wave Signals	Rediker, R.H. Leonberger, F.J. Greenwood, D.P.	17 Jan 89
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4,813,762	Coherent Beam Combining of Lasers Using Microlenses and Diffractive Coupling	Leger, J.R. Veldkamp, W.B. Scott, M.L.	21 Mar 89
4,816,420*	Method of Producing Tandem Solar Cell Devices from Sheets of Crystalline Material	Bozler, C.O. Fan, J.C.C. McClelland, R.W.	28 Mar 89
4,822,120*	Transparent Heat-Mirror	Fan, J.C.C. Bachner, F.J.	18 Apr 89
4,831,340	Harmonic Multiplier Using Resonant Tunneling Device	Sollner, T.C.L.G.	16 May 89
4,834,834	Laser Photochemical Etching Using Surface Halogenation	Ehrlich, D.J. Rothschild, M.	30 May 89
4,837,182*	Method of Producing Sheets of Crystalline Material	Bozler, C.O. Fan, J.C.C. McClelland, R.W.	6 Jun 89
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4,848,880	Spatial Light Modulator	Aull, B.F. Goodhue, W.D.	18 Jul 89
4,853,076*	Semiconductor Thin Films	Tsaur, B-Y. Fan, J.C.C. Geis, M.W.	1 Aug 89
4,856,068	Audio Pre-Processing Methods and Apparatus	Quatieri, T.F. McAulay, R.J.	8 Aug 89
4,860,304*	Solid State Microlaser	Mooradian, A.	22 Aug 89
4,864,378	Schottky Barrier Infrared Detector	Tsaur, B-Y.	5 Sep 89
4,865,427	Spatial Light Modulator	Kingston, R.H. Leonberger, F.J.	12 Sep 89
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4,881,237	Hybrid Two-Dimensional Surface-Emitting Laser Arrays	Donnelly, J.P.	14 Nov 89
4,885,790*	Processing of Acoustic Waveforms	McAulay, R.J. Quatieri, T.F.	5 Dec 89
4,889,583*	Capping Technique for Zone-Melting Recrystallization of Insulated Semiconductor Films	Chen, C.K. Tsaur, B-Y.	26 Dec 89
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4,894,840*	Surface Emitting Laser	Liau, Z-L. Walpole, J.N.	16 Jan 90

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4,903,089	Vertical Transistor Device Fabricated with Semiconductor Regrowth	Hollis, M.A. Bozler, C.O. Nichols, K.B. Bergeron, N.J.	20 Feb 90
4,937,873*	Computationally Efficient Sine Wave Synthesis for Acoustic Waveform Processing	McAulay, R.J. Quatieri, T.F.	26 Jun 90
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4,959,653	Adaptive Sidelobe Blanker	Ganz, M.W.	25 Sep 90

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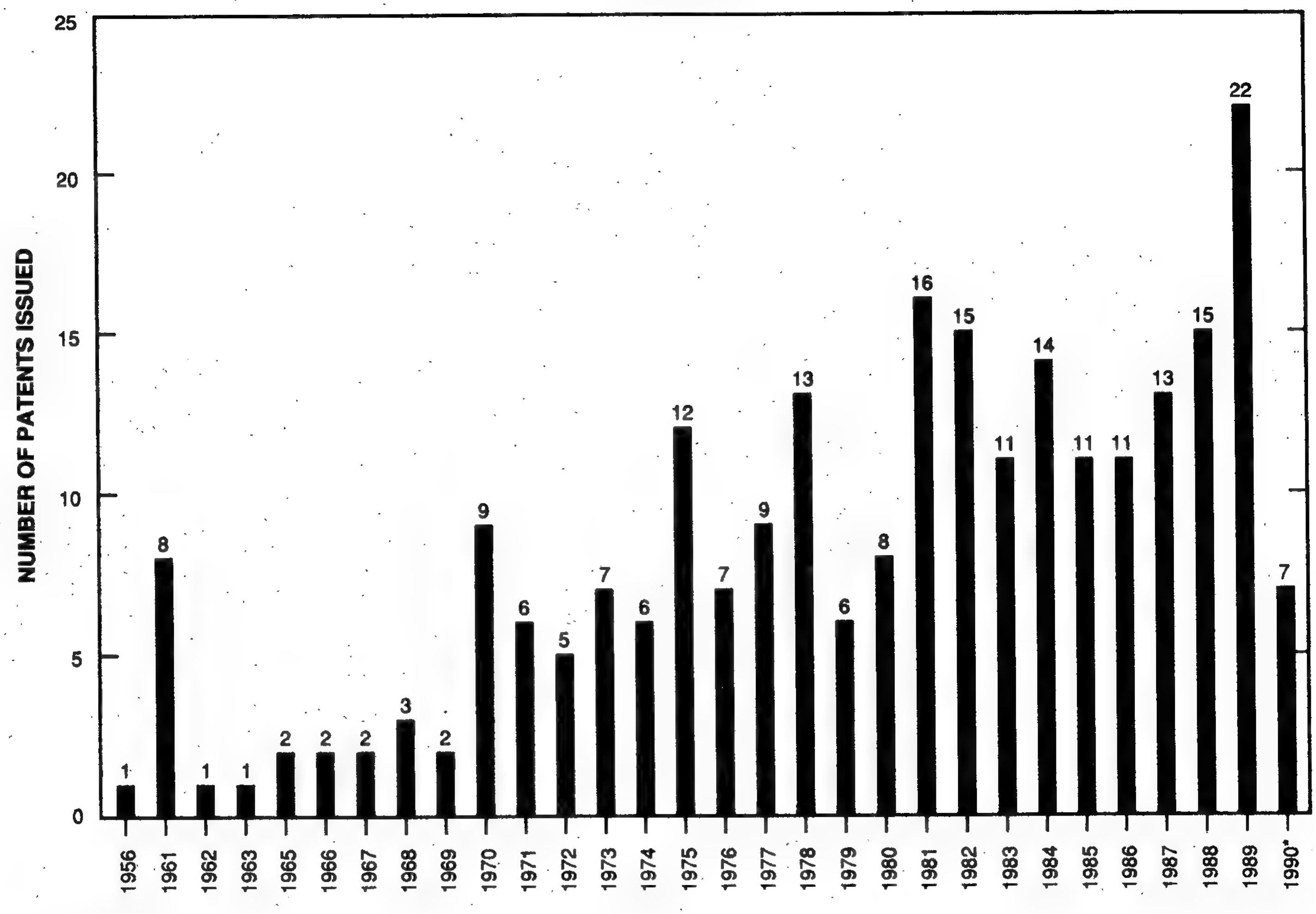

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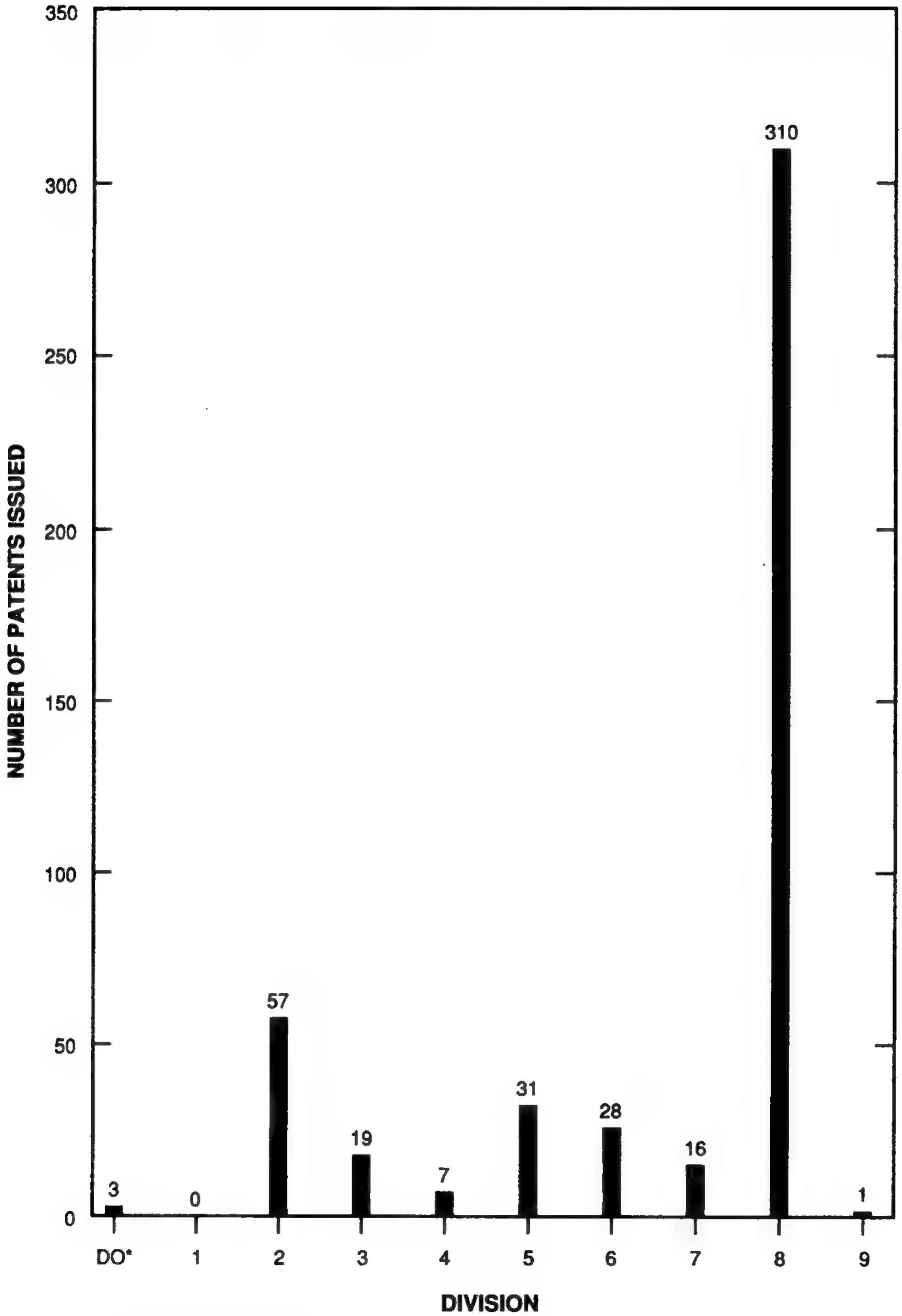

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Subject Index

REPORT DOCUMENTATION PAGE

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1. AGENCY USE ONLY (*Leave blank*)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED

4. TITLE AND SUBTITLE

Bibliography of Patents and Licenses
1951–1990 1991 Edition

5. FUNDING NUMBERS

C — F19628-90-C-0002

6. AUTHOR(S)

Comp. and ed. by Robert G. Hall
Jean E. King
Mary L. Murphy

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Lincoln Laboratory, MIT
P.O. Box 73
Lexington, MA 02173-9108

8. PERFORMING ORGANIZATION REPORT NUMBER

17-1015

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

HQ Electronic Systems Command ESC/ENKL
Hanscom AFB, MA 01730-5000

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

ESC-TR-94-101

11. SUPPLEMENTARY NOTES

None

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT (*Maximum 200 words*)

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14. SUBJECT TERMS

patents	inventors	x-ray lithography	solid state laser
licenses	computers	graphoepitaxy	parallel processing network
technology transfer	semiconductors	bifocal lens	optical modulators
inventions			

15. NUMBER OF PAGES

86

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	Unclassified

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by AMSI Std. 239-18
298-102